april, 1961

nlgi spokesman

journal of the national lubricating grease institute

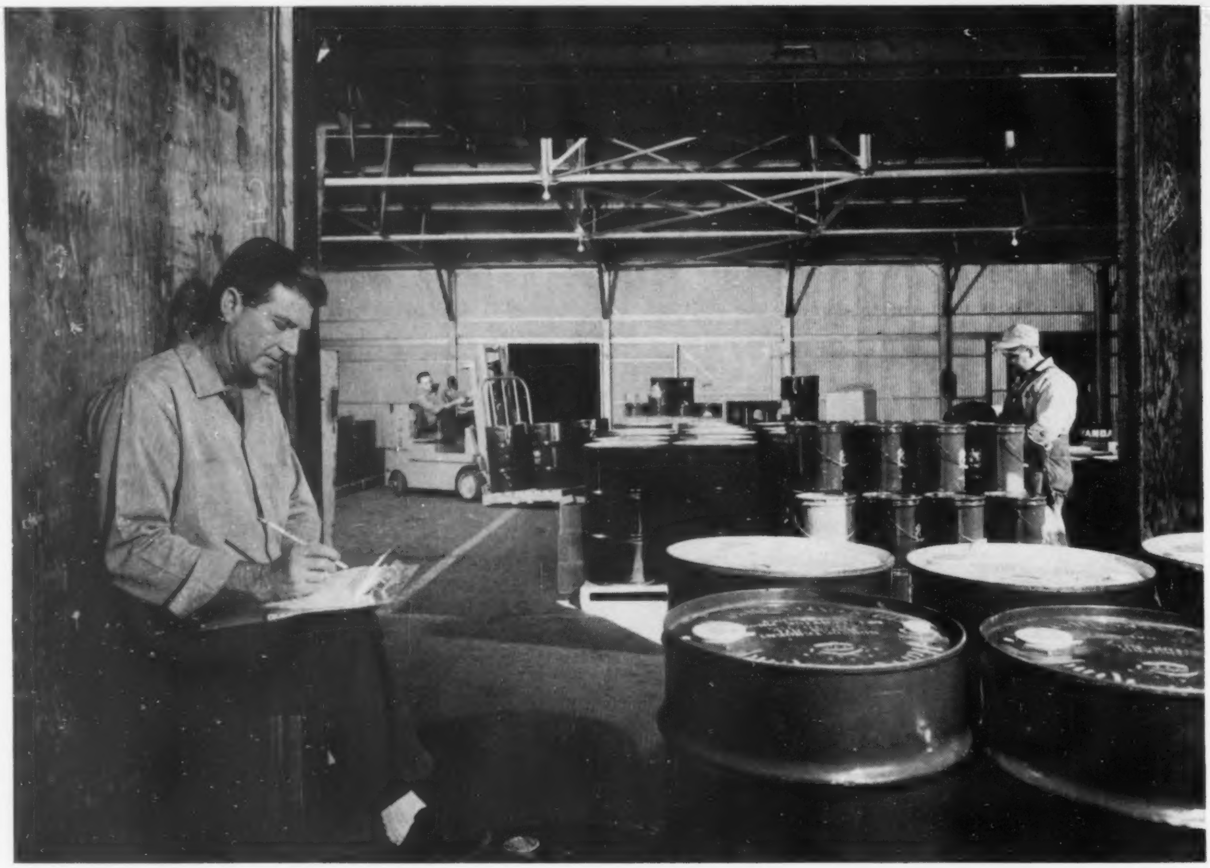
Quality Control Tests for Use in Grease Plants

By T. R. WELCH

Centralized Lubricating Systems

By R. B. YAHN

NLGI Technical Committee Organization



nlgi spokesman

Volume XXV April, 1961 Number 1

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IN THIS ISSUE

THE COVER

OBVIOUSLY, this picture has nothing to do with lubricating grease, per se, but there *is* a timely tie-in with NLGI. Some members may wish to plan on seeing the boats on the canal at the famous floating gardens of Xochimilco, just fifteen miles from Mexico City — after the Annual Meeting at the Rice Hotel, in Houston, October 29-November 1, 1961. Many NLGI'ers intend to go to Mexico following the convention and this six-month advance notice is designed to remind you of the attractions of Houston and beyond, in the fall of the year. A warm welcome is extended to NLGI's international friends and members. *Photo: Mexican Government Tourism Dept.*

NLGI PRESIDENT'S PAGE

By F. R. HART, *President*

What Lies Ahead?

Over the years, I have found it prudent to focus one eye on the future, as a means of keeping in step with the present. Consistent with this philosophy, recently I asked several of the nation's foremost lubricating grease scientists to give me their best guess as to the type and kind of lubricating greases we will be marketing in the year 2000. I suppose some of you will conclude, "This is not my problem; leave it to the lubrication engineer of the future."

Possibly so, but we of today have the dual responsibility of making premium lubricants for today's machinery and, in so doing, lay the groundwork for the lubricants needed in the machines of tomorrow.

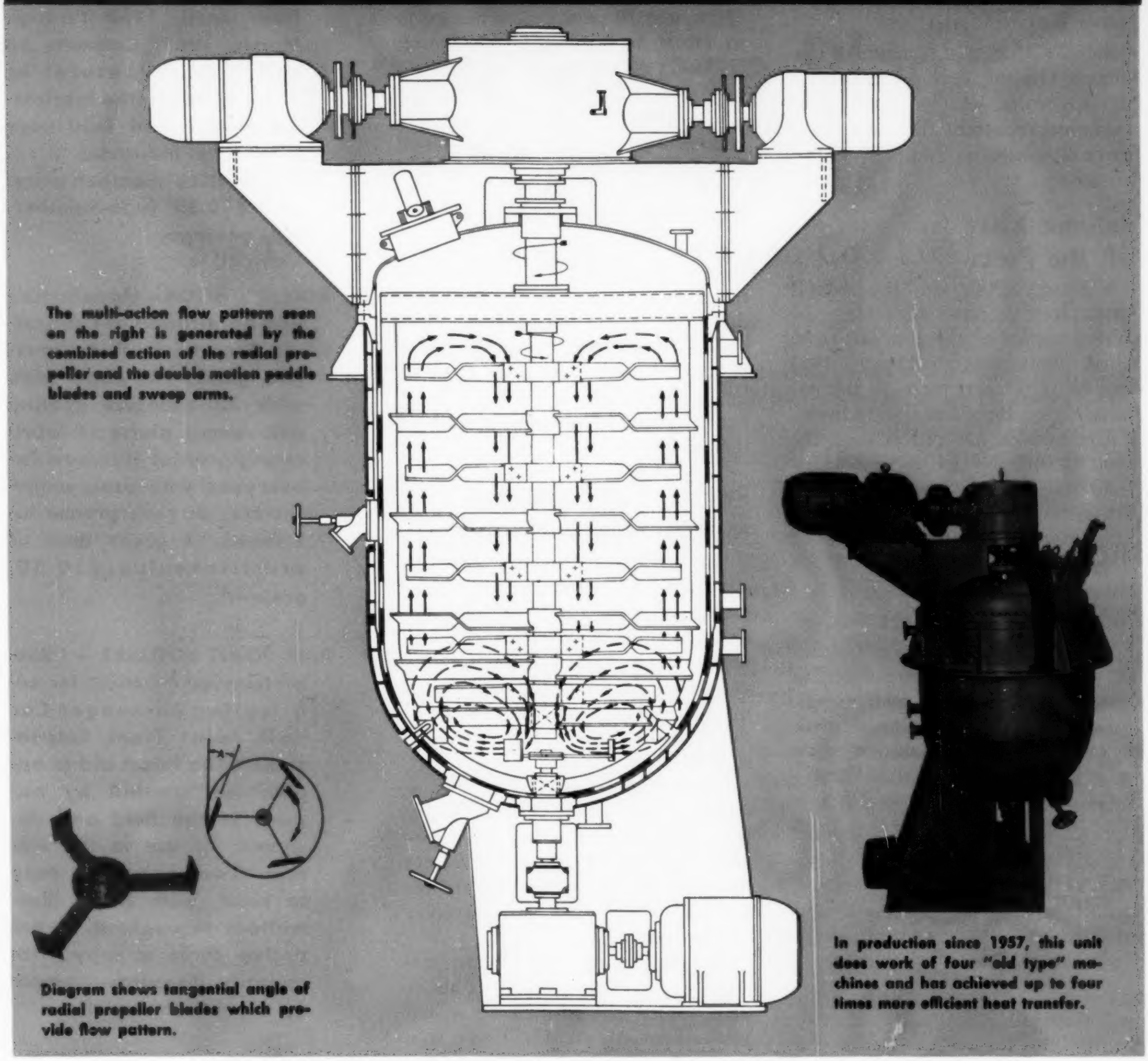
From time memorial, man has been trying to penetrate the misty future to capitalize on the opportunities that lie ahead. For instance, my local newspaper predicts "California expects 20 million registered automobiles within 40 years." The January 1961 issue of *Reader's Digest* contains an interesting forecast on the mighty B-70 Bomber. This jet-propelled airplane was conceived in 1954, designed in 1958, and will probably make its maiden flight in 1962. It is intended for strategic defense during the 1965-75 period. These are prime examples of forward planning. I am sure you can think of many others.

Over the years, we have watched the fabulous development of today's automobile; we have witnessed the almost human operation of the mechanical cotton picker and the unbelievable power of the diesel locomotive railroad engine—to name a few. Each new development has had its effect on lubricating grease, as we know it today. It is to be expected newer machines —operating under fantastic conditions—will be conceived, built and operated in the years that lie ahead. It is with this thought in mind it may be prudent to peek into the future. The first of several scientific forecasts will appear in the May issue. Watch for it—you will be amazed to read of the products and service conditions our industry will face during the next forty years.

MULTI-ACTION GREASE MIXER

developed by STRUTHERS WELLS

increases production up to 4 times—saves time, 30% to 80%



The multi-action flow pattern seen on the right is generated by the combined action of the radial propeller and the double motion paddle blades and sweep arms.

Diagram shows tangential angle of radial propeller blades which provide flow pattern.

In production since 1957, this unit does work of four "old type" machines and has achieved up to four times more efficient heat transfer.

The design of the bottom entering radial propeller agitator augments the "top to bottom" flow pattern generated by the pitched arms and paddles of the double motion agitator as shown above. The result is excellent mixing and shearing action. This combined action not only increases production (up to four times) and saves production time (30% to 80%), but it also assures complete working of the grease. Write us about your grease mixing problems. Ask for copy of 12-page paper, "Grease Mixer Design."

Struthers Wells

STRUTHERS WELLS CORPORATION

MIXING EQUIPMENT DIVISION, WARREN, PA.

Plants in Titusville and Warren, Pa.

News About NLGI

New Representative

Battelle Memorial Institute of Columbus, Ohio, a Technical member, has appointed R. L. Jentgen as Technical representative. S. L. Cosgrove continues as Company representative.

Volume XXIV Is Off the Press

Volume XXIV of the NLGI Spokesman is now available . . . twelve copies of the journal, from April, 1960 through March, 1961 may be purchased through the national office. Bound in the traditional green cover, lettered in gold, the book is offered to members for $7.50 and non-members for $10.50, plus postage.

NLGI's Little Man Now Available in Postage Meter Slugs

NLGI's little promotion character (*see cut*) is now available in Pitney-Bowes postage meter slugs, for advertising on company mailings. Users should contact their local P-B office or write Pitney-Bowes at Stamford, Conn. Price is $15.

The Wednesday, May 10 deadline is drawing near for contestants in the Institute's contest to give NLGI's little man a name . . . over 20 lubrication men have submitted more than 70 prospective names, in an effort to name the promotion character and win the $50 prize.

The winner will be announced shortly after the closing date and employment of the new name will begin immediately.

Board Meeting Change

There will be a meeting of the NLGI Board of Directors on Saturday, May 13, 1961, at the Diplomat hotel, Hollywood Beach, Florida. The meeting site has been changed to conform with the Lubrication committee of API's Marketing division, which follows at the Diplomat.

Review of Spokesman Membership Subscriptions

All member firms are entitled to a certain number of complimentary copies of the NLGI Spokesman, based on the dues paid. Although changes are enacted as soon as received at the national office, many member subscriptions are outdated due to promotions, transfers and reassignment of duties.

Accordingly, NLGI has instituted a periodic review of membership subscriptions to the journal. Company representatives will receive the lists in effect at the national office and be given the opportunity to correct them.

Member firms wishing to purchase extra subscriptions above their quota are entitled to a half price discount, or $2.50 per subscription per year.

SERVICE AIDS

Send Orders to: National Lubricating Grease Institute, 4638 Nichols Pkwy., Kansas City 12, Mo.

VOLUME XXIV—Bound Volume of the NLGI SPOKESMAN from April, 1960 through March, 1961. Contains 38 articles and features on every phase of the lubricating grease and fluid gear lubricants industries . . . $7.50 (NLGI member price) and $10.50 (non-member) plus postage.

BONER'S BOOK—Manufacture and Application of Lubricating Greases, by C. J. Boner. This giant, 982-page book with 23 chapters dealing with every phase of lubricating greases is a must for everyone who uses, manufactures or sells grease lubricants. A great deal of practical value. $18.50, prepaid.

BALL JOINT BOOKLET — "Recommended Practices for Lubricating Passenger Car Ball Joint Front Suspensions." The latest aid in application, created by experts in the field and designed for use in the station. Twelve pages, easy to read, with large illustrations throughout. Twenty-five cents a copy with quantity discounts—company imprint arranged.

CATO MOVIE — "Lessons to be Learned from the Cato Grease Plant Fire." A 16-mm sound movie, 26 minutes, depicting how to avoid a fire in a lubricating grease manufacturing plant with step-by-step procedures.

Presented by G. N. Griffiths at the NLGI 28th annual meeting in Chicago, October, 1960

Quality Control Tests For Use in Grease Plants

Tentative Oil Release Test

By: T. R. Welch, British Petroleum Co., Ltd.

Introduction

At present, the only method other than service performance which provides any practical assessment of grease quality is repeated rig testing. This is not a realistic control test for manufacturing purposes since the time required to carry out such testing is too long. Consequently it was decided to attempt the development of rapid laboratory tests which would give results correlating with those from full-scale rig tests.

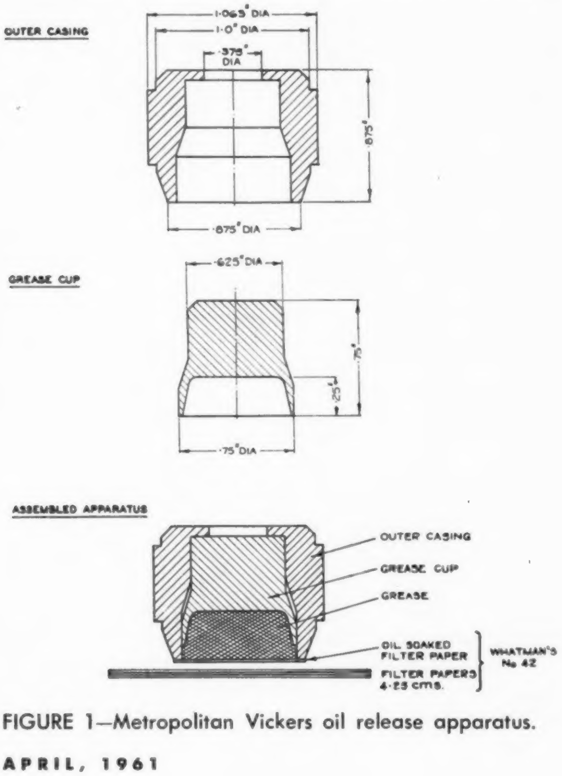


FIGURE 1—Metropolitan Vickers oil release apparatus.

For this purpose greases which have been rig tested are being characterized in terms of yield value-temperature curves, apparent viscosity at various temperatures and shear rates, thermal stability, oxidation stability and oil release (the rig testing was done in a Skefko type R2F rig, following the Skefko standard procedures 2 and 3).* It is considered that the combined assessment of grease quality provided by the above properties will eventually make it possible to reduce rig tests in grease plants considerably. This paper is concerned solely with the contribution made by oil release.

It is generally agreed[1,2] that the separation of oil from greases while under pressure in application devices is principally the result of a filtering action or a pressure gradient through the grease. Similarly it is considered that the release of oil from a grease in a bearing is at least partly governed after the clearing stage by the existence of a pressure gradient through the grease. Consequently the most likely approach for studying the release of oil from greases in service is

*The Skefko R2F rig consists essentially of two 60 mm bore spherical roller bearings mounted on a horizontal shaft. Each bearing operates under a radial load of 851 kg. The main test conditions of procedures 2 and 3 are as follows:

Procedure 2
Speed .... 2500 rpm
Duration .... 28 days
Temperature—Natural (no artificial heating)

Procedure 3
Speed .... 2500 rpm
Duration .... 20 days
Temperature—Gradually raised from ambient to 115°C (14 days of test is at 85° to 90°C)

one in which the grease is subjected to a pressure gradient or filtering action.

After a survey of work carried out on leakage of oil from greases, it was decided that the Metropolitan Vickers Oil Release Test provided the best starting point for the work and the present paper describes the correlation of a slightly modified version of this test with the Skefko rig performance of various greases. Most of the work has concentrated on lithium hydroxystearate greases intended for industrial applications because here the highest quality is often necessary.

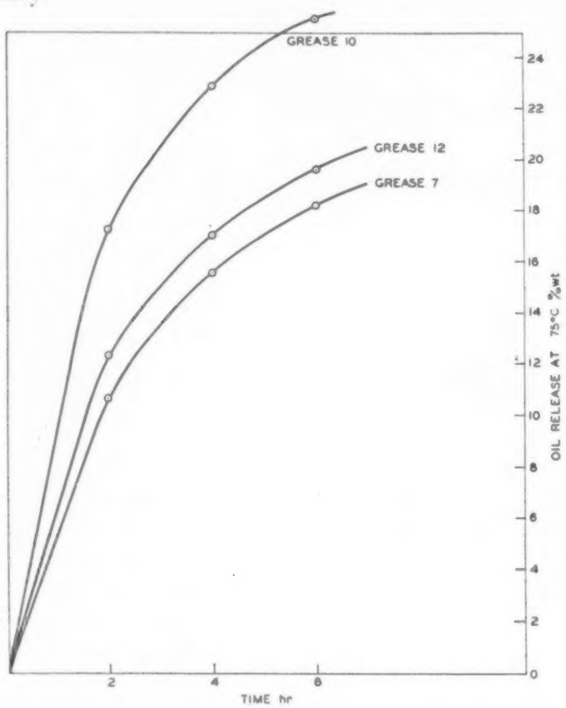


FIGURE 2—Typical oil release-time curves for lithium hydroxystearate greases.

Experimental

Oil Release Apparatus

The apparatus used for this work is that of Metropolitan Vickers[3], the main details of which are given in Figure 1. Essentially this apparatus consists of a brass cup and a brass outer casting. The parts must be such a fit on the 0.625 inch and 0.75 inch diameters that although the cup will slide freely into the casing, there shall be no appreciable side-play. Both parts must have a smooth finish.

Development of Test Conditions

For this purpose eight Skefko rig tested lithium hydroxystearate greases were used for the preliminary work which was aimed at establishing the best test conditions from the viewpoint of correlation with Skefko rig performance. The initial experiments indicated that the most satisfactory method for measuring the amount of oil release is weighing the test apparatus plus grease before and at the end of the test period. Using this technique, the variation of the amount of oil release with time at temperatures in the range 20° to 120°C. was studied. Typical oil release-time curves are shown in Figure 2.

An attempt was made to find a linear relationship of oil release with time and the mechanism of oil release was considered as a rate process by plotting log (a-y) against t where a is the oil content of the grease and y is the amount of oil release at time t but straight lines did not result. Several empirical plots[1,5] were tried and the best straight lines resulted when oil release was plotted against log time as shown in Figure 3. However, no significant differences were shown between the slopes and intercepts of the lines for greases which passed and failed the rig tests.

The variation of oil release with temperature at a constant test period was also studied and some typical curves are shown in Figure 4. If a two-hour test period at temperatures greater than 75°C was used, the level of oil release was frequently greater than 25 per cent and it was found that at this level of oil loss serious discrepancies between repeat results became apparent. If, at these higher temperatures, a shorter test period was employed, for example, one hour, it was found that insufficient differences between pass and fail Grade 2 greases were revealed for the test to be of value in terms of correlation with Skefko rig performance.

The most significant and repeatable results of all the work on the eight greases were obtained using two test conditions, two hours at 75°C and six hours at 25°C. Precise details of the oil release test as carried out at these two test conditions, which were used for all subsequent work are described in the Appendix.

Work Done and Results Obtained

In view of the promise of the initial experiments, repeatability measurements were carried out on two

Grease	Oil Release after 6 hr at 25°C % wt		Oil Release after 2 hr at 75°C % wt	
	Component Results of Triplicate Determinations	Geometric Mean of Triplicate Determinations	Component Results of Triplicate Determinations	Geometric Mean of Triplicate Determinations
10	8.6 8.6 7.9	8.4	17.5 16.6 15.6	16.6
	9.2 9.9 8.3	9.1	16.6 16.8 18.3	17.2
	9.5 9.0 8.9	9.1	17.4 18.4 18.3	18.0
12	5.9 5.4 5.3	5.5	13.0 12.5 11.8	12.4
	5.5 6.2 5.8	5.8	12.8 12.1 12.6	12.5
	5.0 5.3 5.4	5.2	12.3 11.3 13.3	12.3

TABLE 1—Precision of oil release test.

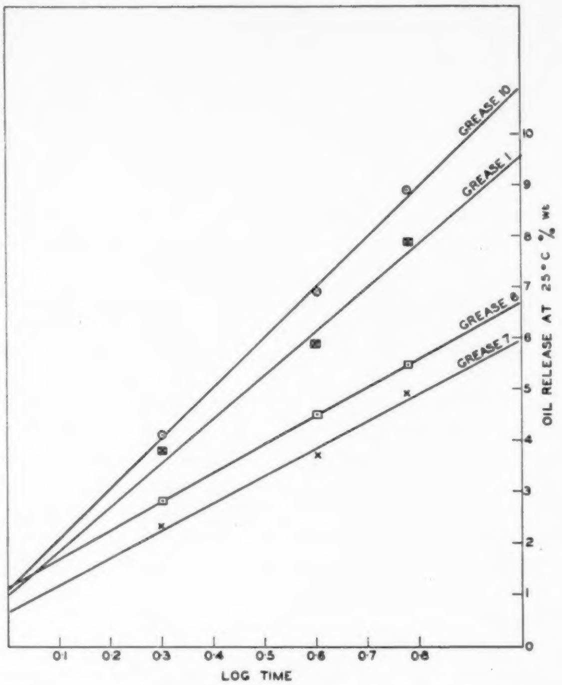


FIGURE 3—Typical oil release-log time curves for lithium hydroxystearate greases.

greases using both test conditions and the results of these measurements are given in Table 1.

Oil release determinations were then carried out on the lithium hydroxystearate greases listed in Table 2. The rig performance of these greases are also given in Table 2 and the corresponding results of the determinations are shown in Table 3 in order of decreasing oil release.

The work was then extended to a number of greases based on thickeners other than lithium hydroxystearate. The results of the oil release measurements on these latter greases are shown in Table 4. The effect of consistency on oil release for all the above greases has also been studied at 25°C and Figures 5 and 6 show the plot of oil release against worked penetration.

Discussion

Factors Affecting the Release of Oil from Soap-Thickened Greases

The preliminary work on the variation of oil release with time as shown in Figure 2 indicates that the amount of oil release increases at first quite rapidly with time and then tends to level off. The levelling off tends to indicate that the greater the oil content of the grease, the more rapid is the release of oil. This conclusion is supported by the work of Carmichael and Robinson.[1] The same authors also show that the percentage of oil release decreases as the viscosity of the oil increases, which is no doubt at least partly responsible for the fact that normally increase of temperature accelerates oil release (see Figure 4).

Other work[1,6,7,8] indicates that the amount of oil release increases as the amount of soap decreases, as the differential pressure through the grease increases and as vibration increases; it is also dependent on the grease structure and the nature of the soap cation.

Precision of Oil Release Measurements

The precision of the oil release test has not yet been determined by statistical examination. Until the test has been established on a more permanent basis, it has been tentatively assumed that the precision will be at least equal to that of the Institute of Petroleum "oil separation on storage of grease" test (IP 121/57) to which in some respects it is related.

In the IP 121/57 test method, it is stated that when duplicate test results, each being the geometric mean of three determinations, are obtained, the larger result should not exceed the smaller by more than 20 per cent of the smaller result.

Analysis of actual test results (geometric means of triplicate determinations) in Table 1 indicates that for grease 10 the largest difference between any pair of repeated test results is 8.3 per cent at the 25°C test condition and 8.4 per cent at the 75°C test condition; for grease 12 the corresponding figures are 11.5 per cent and 1.6 per cent respectively. Therefore all the results in Table 1 easily satisfy the precision of the IP 121/57 test.

Grease	Worked Penetration IP 50	Skefko Rig Performance	
		Procedure 2	Procedure 3
1	271	Excellent pass	Good pass; slight oil separation
2	261	-	Lubrication satisfactory; lacquer excessive
3	257	-	Borderline; failed one test, passed next test. Negligible oil separation
4	255	Very good pass	-
5	253	-	Borderline; wear on one track only. Negligible oil separation
6	240	Excellent pass; no oil separation	-
7	239	-	Fail; track wear, no oil separation
8	238	Excellent pass; no oil separation	Lubrication satisfactory; lacquer excessive
9	232	Excellent pass	Fail; track wear, no oil separation
10	298	-	Very good pass; slight oil separation
11	265	Pass; oil separation was very slight	-
12	229	-	Pass; negligible oil separation
13	221	Pass; no oil separation	Pass; negligible oil separation
14	285	Fail; track and cage wear	Fail; excessive leakage and lacquer deposits
15	284	-	Fail; heavy oil leakage
16	254	Very good pass	Pass
17	249	Pass; negligible oil separation	Borderline fail; slight wear and lacquer deposits

Greases 1 - 9 contain base oil X
" 10 - 13 " " " Y
" 14 - 17 " miscellaneous base oils

TABLE 2—Skefko rig performance of lithium hydroxystearate greases studied by oil release test.

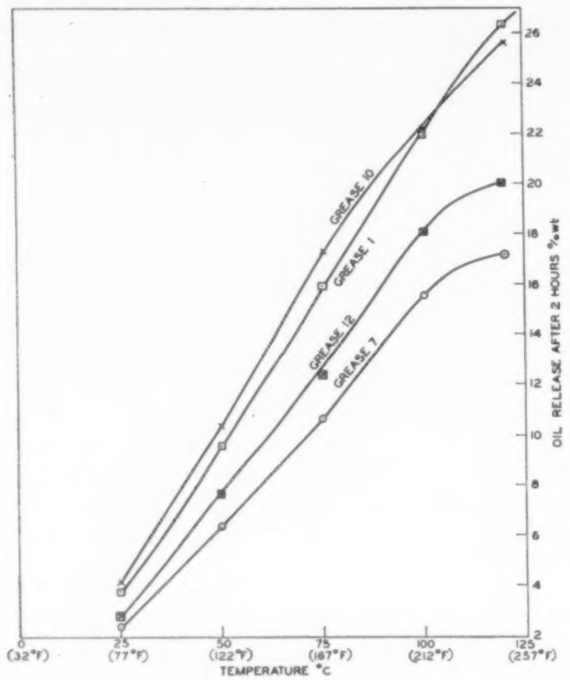


FIGURE 4—Typical oil release-temperature curves for lithium hydroxystearate greases.

Interpretation of the Results on Lithium Hydroxystearate Greases

From the oil release results shown in Table 3, it appears desirable for a best-quality Grade 2 or 3 lithium hydroxystearate grease to have the amount of oil release in the range of 5 to 10 per cent weight after six hours at 25°C and 11 to 18 per cent weight after two hours at 75°C. In the six hours at 25°C results, three results, namely, those for greases 7, 9 and 15 fall outside the tentative limits. Both greases 7 and 9 have exhibited a very dry character in the rigs while grease 15 has failed mainly through marked oil separation. Greases 12, 6, 5, 3, 16, 13, 17 and 8 have shown little or no apparent oil separation in the rigs while greases 10, 11, 1, 2, 14 and 4 have tended to exhibit very slight oil separation. Thus the oil release test is giving some correlation in terms of whether a grease will tend to run dry or exhibit oil separation in the Skefko rigs.

General support for the correlation of this type of oil release test with rig performance has been found by Vose,[9] and it is significant that Metropolitan Vickers have incorporated their oil release test[3] into their Purchasing Specification in which it is stated that after six hours at 20°C "the oil released from the grease in this test shall be between 5 and 10 per cent of the original weight of grease and shall preferably be nearer the upper limit."

Greases 14, 17, 3 and 5 fall within the 5 to 10 per cent weight range of oil release after six hours at 25°C and yet have failed or apparently been close to failure in Skefko rig tests because of wear or oil separation. It must therefore be concluded that optimum oil release from a grease is not by itself a sufficient guarantee that a grease will lubricate adequately a rotating roller bearing. Other factors such as the rheological properties of the grease over a wide temperature range no doubt play a vital part, particularly if at higher temperatures lubrication by released oil is not adequate due to a lowered oil viscosity and then good performance would be dependent on how well the grease as a whole could lubricate the bearing.

A similar analysis to that carried out on the six hours at 25°C results holds for the oil release test results using the two hours at 75°C conditions and as can be seen from Table 3 the over-all level of oil release is higher than was the case at 25°C. The main advantages of these conditions over that of six hours at 25°C are that the test is shorter and it gives an indication of the effect of temperature on the oil release properties of the grease. With respect to this latter advantage, the two hours at 75°C test condition is probably more realistic than that at 25°C because in high speed applications the temperature of the grease will be much closer to the higher value.

The most useful and interesting aspect of the test results at 25°C is shown in Figure 5 by the plot of the oil release against the worked penetration. The worked penetration is determined by the amount, type and viscosity of oil, by the amount and type of soap and by the grease structure. Since the pressure gradient, filtering action and temperature are constant in the oil release test and there is no vibration, then the position of each grease on the graph is governed mainly by the

Grease	Oil Release after 6 hr at 25°C	Overall* Skefko Rig Performance	Grease	Oil Release after 2 hr at 75°C	Overall Skefko Rig Performance
15	11.6	Fail	15	19.7	Fail
10	8.9	Pass	10	17.3	Pass
11	8.7	Pass	11	16.8	Pass
1	7.9	Pass	17	16.2	Borderline Fail
2	7.9	Pass	1	16.0	Pass
14	7.8	Fail	14	15.2	Fail
4	7.5	Pass	3	13.5	Borderline
8	7.1	Pass	5	13.5	Borderline
17	6.8	Borderline Fail	13	13.1	Pass
13	6.1	Pass	16	12.9	Pass
16	6.0	Pass	6	12.7	Pass
3	6.0	Borderline	4	12.5	Pass
5	5.9	Borderline	12	12.4	Pass
6	5.5	Pass	2	11.5	Pass
12	5.5	Pass	8	11.4	Pass
7	4.9	Fail	7	10.7	Fail
9	4.7	Fail	9	9.5	Fail

* Fail implies definite failure in either procedure 2 or 3 test in terms of wear or leakage.

TABLE 3—Level of oil release in lithium hydroxystearate greases.

degree to which the bulk oil is bound by the thickener. The optimum "corridor" region, into which a best-quality grade 2 and 3 lithium hydroxystearate grease should fall, has been fixed using rig performance as the "yardstick." It must be emphasized, however, that the limits of this "corridor" are tentative and cannot be fixed firmly until the theory has been tested further with a considerably greater number of greases of established rig performance.

Three lithium hydroxystearate greases fall clear of the "corridor" region shown in Figure 5. Grease 15 is well above the higher limit which indicates that the oil is held too loosely by the soap and this conclusion is supported by the rig test result. Greases 7 and 9 fall just below the lower limit which indicates that the oil tends to be held rather too strongly and again this conclusion is supported by the dry character exhibited by both greases in the rigs. The fact that grease 14, a definite failure, and greases 3, 5 and 17, all of borderline quality fall within the tentative limits supports the authors' opinion that optimum oil release properties cannot alone guarantee satisfactory lubrication in Skefko rig tests and that other factors such as mechanical stability, rheological properties and oxidation stability are equally important.

This preceding type of analysis is of use when a series of similar greases is being studied as would be the case of batch control in a grease plant. For example, lithium hydroxystearate greases 1 to 9 are all made from the same lubricating oil and it seems logical to suppose that the yield (penetration/soap content relationship) of greases 7 and 9 is poorer than that of the remaining seven greases which would explain the dry character exhibited by greases 7 and 9. From this example, it is not difficult to see the value of the oil release test in the study of grease manufacturing variables and in fact this type of approach is already being used in the development of improved manufacturing processes.

Interpretation of the Results on Other Greases

An example of the use of the oil release test in grease formulation is provided by experimental greases A, B and C (see Table 4 and Figure 6). From the results on B and C, it appeared that this particular type of grease would be improved by using a lower viscosity base oil. This deduction was shown correct by the improved lubricating properties of grease A which was made

Grease	Worked Penetration IP 50	Thickener	Oil Release		Skefko Rig Performance	
			6 hr at 25 °C	2 hr at 75 °C	Procedure 2	Procedure 3
A	256	Experimental Lithium Soap	6.8	12.0	Good pass	-
B	251		4.6	9.9	Fail; heavy wear	-
C	250		4.8	10.2	Fail; heavy wear	-
D	305	Bentone	3.2	6.7	Fail; heavy wear	Lubrication unsatisfactory in sorting test
E	288	Bentone	5.8	9.7	Fail; heavy wear	Lubrication unsatisfactory in sorting test
F	255	Aerosil	5.7	9.6	Borderline fail; very light wear	-
G	256	Experimental Lithium Soaps	3.9	9.8	-	Lubrication unsatisfactory in sorting test
H	294	Mixed Lithium and Calcium Soaps	3.3	9.8	Fail; cage wear, leakage, churning	Lubrication unsatisfactory in sorting test
I	220	Soda Soap	2.2	4.3	-	Fail; track and cage wear, very dry
J	224	Substituted Urea	5.0	10.2	Fail; wear and considerable leakage	-
K	267	Sodium Terephthalamate	4.6	8.7	Fail; heavy track and roller wear	-

TABLE 4—Oil release results and rig performance of greases based on thickeners other than lithium hydroxystearate.

from an oil of viscosity lower than that used for B and C.

Looking more generally at the results shown in Table 4 and illustrated in Figure 6, it would appear that the conclusions formed from the work on lithium hydroxystearate greases also apply to greases based on other thickeners. However, insufficient evidence is at present available to decide whether or not this is the case for it is quite possible that some greases may lubricate, even at low running temperature, predominantly by grease film rather than oil leakage.

Conclusions

The results obtained by the oil release test described in this paper have shown that the amount of oil released influences the lubricating properties of the grease and that best quality lithium hydroxystearate greases release oil within certain limits. It has been demonstrated that an indication of the degree to which the bulk oil in a grease is held by the thickener can be gained from its oil release and worked penetration.

It appears likely that the conclusions drawn for lithium hydroxystearate greases may well apply to other greases, but it is emphasized that the tentative oil release limits set for industrial lithium hydroxystearate greases may well be unnecessarily close for greases intended for less severe applications.

In addition to the oil release test being suitable for production control of quality in a grease plant, it has potential value both for grease formulation and manufacture. Although the work has indicated that factors other than oil release have a vital influence on its lubricating performance, the general conclusion to be drawn from the results given in this paper is that oil release is a useful property for defining the quality of a grease.

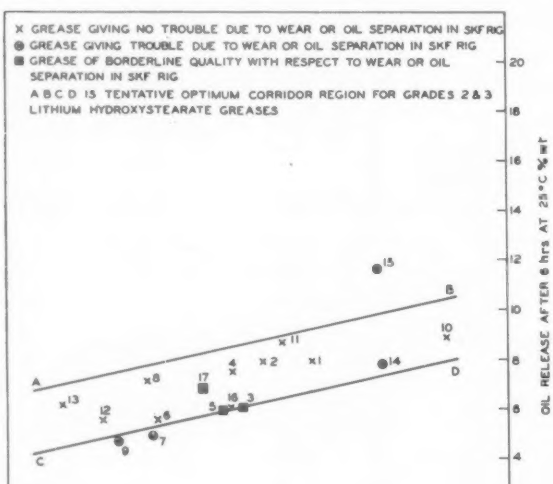


FIGURE 5—Effect of consistency on oil release from lithium hydroxystearate greases at 25°C.

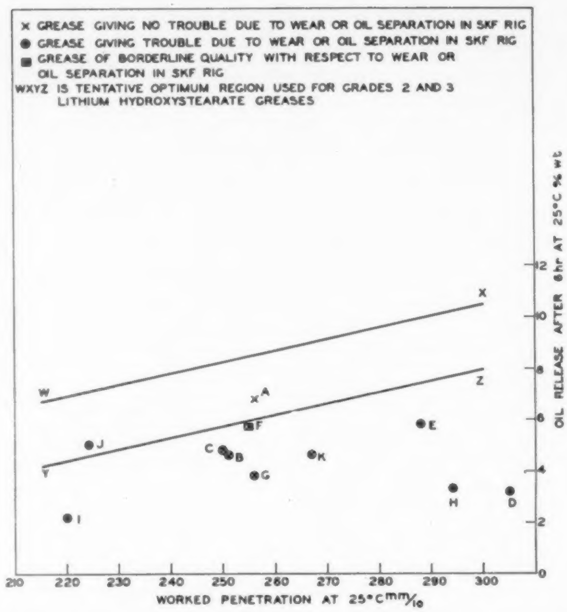


FIGURE 6—Effect of consistency on oil release at 25°C of greases based on thickeners other than lithium hydroxystearate.

Acknowledgments

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Appendix

Oil Release Test

Procedure

A ⅞-inch-diameter disc of Whatman's No. 42 filter paper (slow speed, highly retentive type) shall be placed on a piece of glass plate and saturated with a spindle oil (Saybolt Universal Viscosity at 210°F of approximately 40 sec.). Excess oil shall be removed

from the oil-soaked filter paper by pressing it between two sheets of filter paper until no further oil stains the filter paper sheets.

The clean dry grease cup shall be placed cup uppermost in the outer casing and the cup and casing shall be weighed to the nearest 0.001 g. The cup shall be filled to excess with the grease to be tested; the excess grease shall be cleaned off level with the lip of the outer casing and the whole assembly weighed again (care must be taken to avoid including air in the grease during the packing and levelling operation). The weight of the grease may thus be found. The previously oiled disc of filter paper shall be lightly pressed onto the levelled surface of grease taking care to avoid including air between the paper and the grease surface and the whole assembly reweighed. The now completely prepared apparatus shall be inverted and placed on a pad of four Whatman No. 42 filter papers of 4.25 cm diameter. The procedure now follows either Section (a) or (b) according to which test conditions are being used.

(a) *Six Hours at 25°C Conditions*

At least one hour before the test commences, a glass tank shall be placed in a water bath controlled at 25 ± 0.5°C, so that the level of the water is within 1 to 1½ inches of the top edge of the tank. The top of the tank shall be covered with aluminum foil.

The prepared apparatus shall be placed level within the tank and the aluminum foil cover replaced. After two hours the test apparatus shall be removed from the tank and re-inverted so that the grease cup is cup uppermost (care must be taken not to disturb the oil soak filter paper disc on the grease surface during this operation). The test apparatus shall be inverted and placed on a fresh pad of four Whatman No. 42 filter papers. The whole assembly shall then be returned to the tank for a further two hours when the whole operation of changing the filter pads shall be repeated and the test apparatus returned to the tank for a further two hours. At the end of this third two-hour period the test apparatus including the residual grease and the oil soaked filter paper disc shall be reweighed when the oil loss may be found by difference.

(b) *Two Hours at 75°C Conditions*

The prepared apparatus shall be placed level on a sheet of suitable base material and the whole assembly shall be inserted level into an oven controlled at 75 ± 1°C for two hours. At the end of this period the test apparatus shall be re-inverted so that the grease cup is cup uppermost and transferred to a desiccator. When the test apparatus including the residual grease and the oil soaked filter paper disc has cooled to room temperature, it shall be reweighed when the oil loss may be found by difference.

Note 1. The test shall be carried out in triplicate and if any single result should differ from the geometric mean of the three results by more than 10 per cent the whole determination shall be repeated.

Note 2. If duplicate test results, each being the geometric mean of three determinations, are obtained the larger result should not exceed the smaller by more than 20 per cent of the smaller result.

Note 3. The final result which should be the geometric mean of a satisfactory triplicate determination, shall be reported to the nearest 0.1 per cent weight based on the initial weight of the grease used for the test. ■

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Centralized Lubricating Systems

By: R. B. Yahn

Yahn Engineering & Sales Co., Inc.

HALF A CENTURY ago the only lubricating equipment available were oil and grease cups. The first real modern equipment for the application of lubricants was the pressure gun and grease fitting used on motor-car chassis lubrication about the year 1917. In spite of the very obvious advantage and convenience of a pressure gun and fitting, it was not until 1922 that this method of lubrication was introduced into industrial plants. The savings in lubricant, cleanliness and better lubrication from the high pressure flushing action in the bearing, along with improved quality of lubricants, received immediate acclaim. However, with this method it soon became apparent that many machines had to be shut down in order to lubricate their bearings, and some machines could not wait until the next shutdown for their lubricant. Also, any attempt to lubricate while the machine was in operation involved the risk of injury to the oiler.

The next step in the development of this type of application consisted of grouping the fittings at central stations, readily accessible from the floor level and running individual tubes from each fitting to each bearing. This then was the first application of a centrally-located lubrication system. Crude as it appeared, it served the purpose of lubricating the bearings while the machine was in operation as well as eliminating the hazard of possible injury to the oiler. The oiler now had an important job to do. Only through experience did he know how much lubricant to give each fitting. It became necessary to rely on human element (with no accurate control over the quantity) to deliver lubricant to a bearing. Because the bearings were not visible to the oiler at the time of application, some bearings received too much lubricant, some too little and often some were entirely missed. To assure adequate lubrication, the oilers were inclined to overlubricate a bearing with the eventual result of having dripping from all bearings. In the case of anti-friction bearings, the bearings were packed so tight with lubricant as to resist, instead of aid, transmission of power, thus increasing the power load. In other words, there was no measuring or metering valve for each bearing.

Perhaps the most important advance in centralized lubrication was achieved by the advent of the measuring or metering valves about the year 1930.

Oil can be metered to the bearings in a centralized system by three methods:

1. Orifice
2. Mist
3. Piston Displacement

Centralized systems for handling grease can only be of the piston displacement type.

A brief discussion of the general types of systems available may be of interest. In the orifice type system, a header line is run from the pump and branch lines are run from this header line to a fitting which contains the orifice. This fitting is normally threaded directly into the bearing inlet. These orifices are supplied in various diameters depending on the amount of flow desired. The amount of flow through the ori-

fice is fixed for a given oil viscosity and operating pressure.

The amount of lubricant delivered to the bearings can be altered by adjusting the operating pressure of the system, or by changing the sizes of the orifices.

Another method is mist or fog lubrication. This system consists of micron-sized lubricant particles suspended in air, conveyed to the bearings through extremely low pressure air lines where they are converted to larger-sized oil particles by reclassification fittings and caused to wet out by impingement upon the bearing surfaces. The mist is generated in the misting head which is shown in Figure 1. Air at regulated pressure ranging from 5 psi to 30 psi enters through passage A, passing through orifice B, causing a great increase in velocity in the venturi section C. Simultaneously a low pressure area is created at the lubricant discharge orifice D, so that lubricant is siphoned to this orifice through the visible delivery tube B. As oil enters the high velocity air stream, it is atomized into various micron-sized particles. Only those particles which are two (2) microns or less will remain airborne. The larger particles drop back into the reservoir. A lubricating aerosol of this particle size can be conveyed over considerable distances without danger of excessive condensation within the piping system.

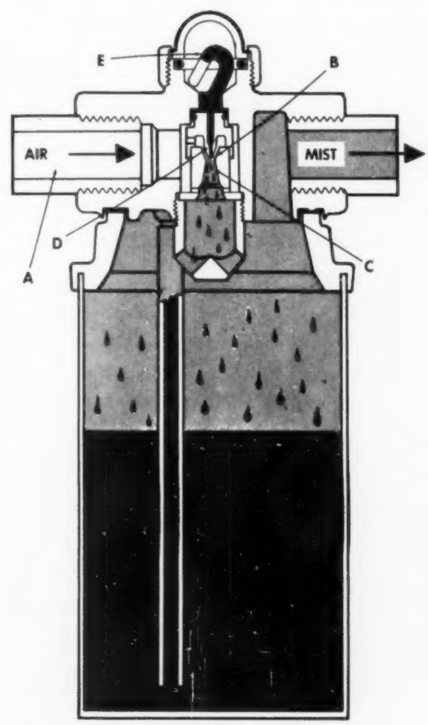

FIGURE 1.

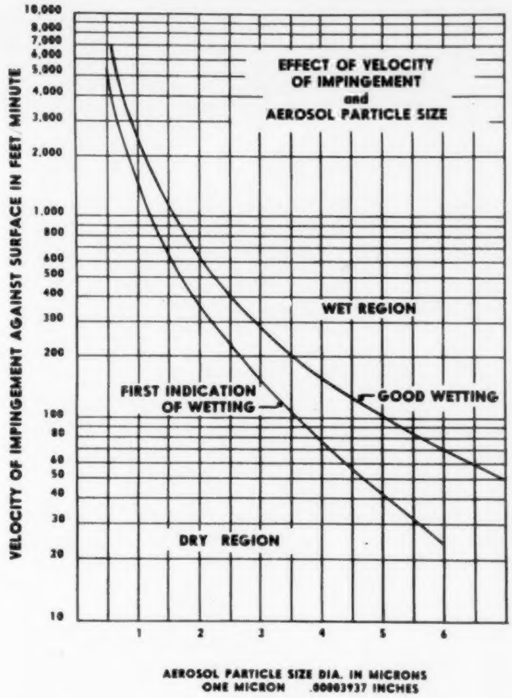

FIGURE 2.

To accurately meter and to convert the mist to a larger particle size, which will wet out upon impingement, reclassifying fittings are used at each bearing inlet. The reclassifying fittings create a slight back pressure in the system which allows control of the metering orifices. The orifices in the reclassifier fittings are designed so that the velocity of the fog will be increased to a minimum of 8000 feet per minute as it passes through the orifice. This causes the oil to wet out as it impinges against the bearing surfaces. A simple demonstration of this principle is shown in Figure 3. In the first case, cigarette smoke is blown gently through a straw at a paper surface held an inch from the straw. No residue will be noted because the velocity of the smoke through the straw with no restriction is too low to reclassify the smoke.

If the end of the straw is folded over so that only a small orifice is created, smoke blown gently through the straw will now leave a stain on the paper if held within one inch of the straw. This is reclassification of some of the tars in the smoke. The same cubic foot per minute of smoke is passing through the straw, but because of the restriction at the end, the velocity is increased sufficiently to cause reclassification.

Mist lubrication has been particularly successful in high speed applications where a stream or bath of oil at speeds of 50,000-300,000 rpm would cause excessive heating due to the churning of the oil.

Both the orifice and mist systems described above are limited to oil application.

The third general type of centralized lubricating

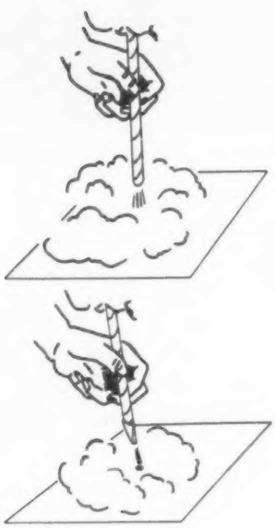

FIGURE 3.

system meters the lubricant through piston displacement and this type can be used with grease as well as oil. There are three general types of piston displacement systems.

1. The single line header system.
2. The dual line header system.
3. The series or progressive system.

The single line system consists of a header line in which spring-loaded injectors are mounted. In this system, a pump delivers lubricant to the header line until all of the injectors have delivered lubricant to the bearings. Pressure is then relieved in the header line so that the spring can force the pistons back, thus priming the injectors for the return stroke during the next lubrication cycle.

In the dual line system, there are two header lines and the pistons are powered in both directions hydraulically. A four-way valve is used to alternately apply and relieve pressure from each of the two headers.

In the series or progressive system, the individual feeders are manifolded so as to form a feeder block. As lubricant is pumped into the inlet of this feeder block, each of the pistons moves in sequence delivering lubricant to the bearings. Each piston must complete its stroke before the next piston moves. This action is much like the piston in your automobile—each one fires in sequence and the speed with which they fire depends, in the case of your automobile, on the rate of fuel being fed into the carburetor; and in the series system, it depends on the rate of feed of the lubricant into the manifold.

Both the header types and series type systems have some things in common. They both meter through piston displacement and because of this, they both will handle grease and oil; and the amount of lubricant introduced into the bearing per stroke of the piston is constant regardless of lubricant viscosity, temperature conditions, back pressures in the lubricant lines and variations in bearing fits. There are, however, some basic differences.

In the header system, when the header lines are pressurized, all of the pistons move, introducing lubricant into the bearings. On most of these systems there is an adjusting screw so that the stroke of the piston can be varied, thus varying the amount of lubricant introduced per stroke. Also, there is normally an indicator pin attached to the piston so that this pin will move with each stroke of the piston, thus giving indication that the feeders are all operating. In these systems, if one line becomes blocked and the piston cannot operate, all of the remaining feeders in the system will continue to operate normally and the plugged line can be observed by failure of the indicator pin to move.

In the series system, there are no indicator pins attached to each metering piston and no adjusting screw to control the stroke of the metering piston. These pistons are supplied in a range of sizes and in designing the system, these feeders are arranged in the manifold so that the feeder size is directly proportional to the bearing area. By using this method, if a bearing is twice as big as another bearing, it receives twice as much lubricant. If it is five times as big, it receives five times as much lubricant, etc. The system is, therefore, proportioned before it is installed. The amount of lubricant delivered to the system is controlled by the operation of the pump, but the proportioning of this lubricant is accomplished by the feeders and this proportion is constant as determined by the layout of the system. In the series system there is no pre-determined operating pressure since, as lubricant is fed into the feeder blocks causing each of the pistons to move in sequence, the pump will apply whatever pressure is necessary to push the piston to the completion of its stroke. In effect, the pump is connected to each piston in sequence and if it requires 50 psi to push the piston to the completion of its stroke, or 1500 psi, the pump will apply this amount of pressure. Therefore, if a gauge is placed in the system, the pressure will normally fluctuate as each of the pistons is moved in sequence. In the case of a blocked bearing or plugged line, when the pump reaches this piston and is unable to push the piston to the completion of its stroke, pressure will increase at the pump, rupturing a safety disc and normally triggering a pressure switch to give indication of trouble. When this happens, the entire lubrication system stops until the trouble has been found and corrected.

These then are the basic differences in the systems. In the header systems, all feeders deliver lubricant each time the header line is pressurized and the amount of

lubricant delivered to the bearing is adjusted by moving each individual adjusting screw. If one feeder stops delivering lubricant, the remaining feeders continue to function. In the series system, the amount of lubricant delivered to the bearings is pre-determined by selecting the feeder sizes in each manifold and it is possible to deliver several shots of lubricant to some bearings, while delivering only a single shot to other bearings. In this system, if any one feeder piston fails to operate, the entire system ceases to deliver lubricant to the bearings.

Over the years there has been quite a controversy between the proponents of each of these systems. The proponents of the header type system say, "Why shut down the entire machine if one bearing fails to receive lubricant?" Proponents of the series type system say, "The one bearing which fails to receive lubricant may be the one which will shut down the entire machine."

Most of the centralized lubrication systems available today are reliable, proven pieces of equipment and will, when applied to machinery, effect the following results:

They will reduce down-time.
They will lower maintenance cost.
They will improve plant safety.
They will lower cost of applying lubricants.

It is not always easy to obtain figures to back up the advantages of centralized lubrication systems as outlined previously. Many times accurate figures are not kept before and after the installation of such a system, and if these figures are kept, there is often a reluctance to divulge them. However, when these figures are divulged, they are in many cases truly amazing.

About four years ago, we had an opportunity to assemble some really significant figures on a large installation. When the Ford Motor Co. built its chassis parts plant seventeen miles north of Detroit, a great variety of machine tools were involved because of the multitude and variety of parts being machined and produced. Everything from relatively simple drills to automatic screw machines, to very complex transfer presses were involved. When this plant went into operation, practically none of this equipment was lubricated by automatic systems. A crash program developed. Approximately $160,000 was spent on lubricating equipment with the following astonishing results:

The annual oil saving—approximately 30,000 gallons.

Approximately 15,000 points were involved and these were being manually but incompletely lubricated by 30 oilers. After the installation, the number of oilers was reduced to ten. Based on annual wages of $5,000 per oiler, the savings per year would, therefore, be $100,000 which means, in labor alone this equipment could be purchased in a year and a half. No record was kept on maintenance cost directly due to lubrication failure. However, there were numerous bearing failures prior to the installation of the system and subsequently these failures were reduced practically to zero.

Incidentally, some time studies were kept on the number of bearings which could be lubricated manually per hour by each oiler and the figure was twelve. This is roughly 100 per day per man, or with 30 men, 3,000 per day. Since there were approximately 15,000 points, you can see that it would take five days to complete the cycle with 30 men on the payroll, and since the majority of bearings require lubrication at least once a day, it is easy to see how maintenance problems would develop.

Let us look at another business which has recently applied centralized lubrication. I refer to the cement industry. One such plant installed systems consisting of three central stations, completely automated with visual and audible alarms in handling 2,300 points on all types of equipment. After the installation was completed, the following annual savings resulted:

Labor	$ 6,000 per year
Bearing Replacement	$24,400 per year
Mechanical Maintenance	$19,500 per year
Decrease in Lubricant Cost	$ 5,000 per year
Total	$54,900 per year

It is also of interest to note in this case that the total cost of the installation of the automatic lubricating system amounted to 1.5 per cent of the total cost of the new plant modernization.

We have some further figures involving the installation of a centralized system on eight lathes in a large aircraft plant in the East. This plant has a very excellent and accurate IBM system for recording downtime and repair and maintenance costs.

Average downtime before the system was installed	97.6 hrs.
After installation	18.2 hrs.
Reduction	82%
Average repair time before installation	34.6 hrs.
After installation	9.9 hrs.
Reduction	71%
Average parts cost per machine per month	28.74
After installation	5.75
Reduction	80%
Total machine downtime per year before installation	9370 hrs.
After installation	1750 hrs.
Reduction	7620 hrs.
Labor savings	$6188
Material	$2208
Total	$8396 per yr.

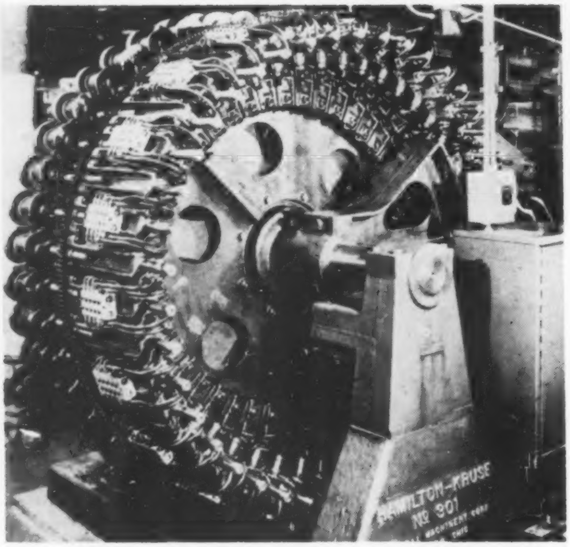

FIGURE 4.

It is of interest to note that the total cost of installation for the eight machines, including both the material and labor, was approximately $3000.

A large rubber manufacturer recently installed a centralized lubrication system to automatically lubricate six rubber mill lines. There were 25 rubber mills involved of various sizes and about 50 line shaft bearings. No figures are yet available on reduction in downtime, bearing replacement, lower maintenance cost, etc., but as an immediate result one oiler was eliminated at an estimated savings of $5000 per year. Total cost of the complete system installed was $7500.

Another example involves a plant making egg cartons on four fully-automated machines and fourteen banks of drying presses. Each of the continuous forming machines has 96 points of lubrication and each bank of fourteen dry presses, 72 points of lubrication, or a total number of 1,392 points. Since these machines operate continuously, twenty-four hours a day, six days a week, they were only lubricated when the equipment was shut down, which was on Sunday. A crew of six men lubricated this equipment each Sunday, receiving double time. The installation of the lubrication system has completely eliminated Sunday lubrication on these machines with a resultant savings in labor, but more important, the machines do not have to wait seven days for a shot of lubricant. They are now lubricated on a time cycle while the machine is in operation, which has resulted in an appreciable power saving with lower maintenance and repair costs.

Another installation involves the equipment shown in Figure 4 in the plant of Cans, Inc., in Chicago. This photo shows an air tester and has 249 points of lubrication, all of which revolve on the machine. An automatic system with a mechanical pump lubricates while the machine is in operation. The savings over hand-lubrication are impressive. Before installing the automatic system, it was necessary to shut down one hour in every eight hours to lubricate—lost time, three hours per day against fifteen minutes now. In terms of production this figures out to be two million cans per year, or a loss in sales of $50,000. Excess lubricant caused many reject cans which has been now reduced to almost zero.

Perhaps one of the most important advantages of centralized systems is improvement in safety and this, of course, is the least tangible. Perhaps the improvement in safe working conditions can best be illustrated by showing a photo involving an installation on an overhead crane (Figure 5). Blast furnace tops, rock crushers and other machinery involving the necessity of the oiler climbing over and under hazardous machinery, many times under adverse conditions, are other examples of the improvement in safe working conditions.

As noted from the foregoing discussion, the advantages of centralized lubrication can be truly amazing. However, those who are involved in the manufacture and sale of this equipment recognize that for these devices to realize their full potential and effect the type of savings outlined previously, it is necessary that they be properly maintained the same as any other piece of equipment. Too often these devices are installed and as long as no trouble develops, they are forgotten. They

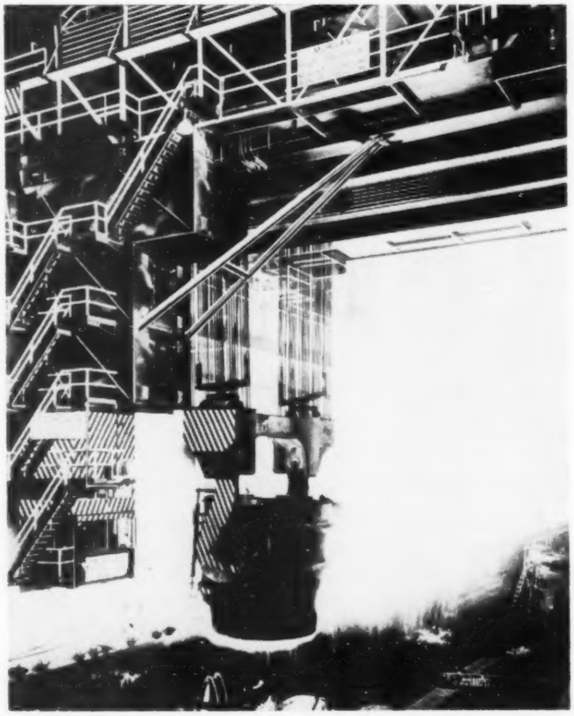

FIGURE 5.

are turned over to the attention of the oiler who traditionally seems to be the lowest paid man in the plant. That working with grease and oil should be considered a menial task rewarded by rates of pay little better than basic is a reversion to the days of oil cans and grease sticks. Capable and conscientious workers cannot be expected to fill these jobs. Capable men initially assigned to lubrication jobs are promoted to better positions concerned with fixing machinery—machinery possibly broken down through the failure of lubrication. The operation and maintenance of grease and oil systems are just as important as the operation and maintenance of any other equipment. The men should be familiar with the mechanical construction of components, principles of system operation and procedures of repair or replacement of parts. After training, they should be retained on the same job just as long as possible.

One of the really encouraging trends in this direction is the increasing number of companies who are undertaking preventative maintenance programs. The first step in almost any preventative maintenance program is to be assured that all of the bearings are being adequately lubricated. This usually means the installation of a centralized lubrication system and also the assignment of trained personnel to check and maintain these systems.

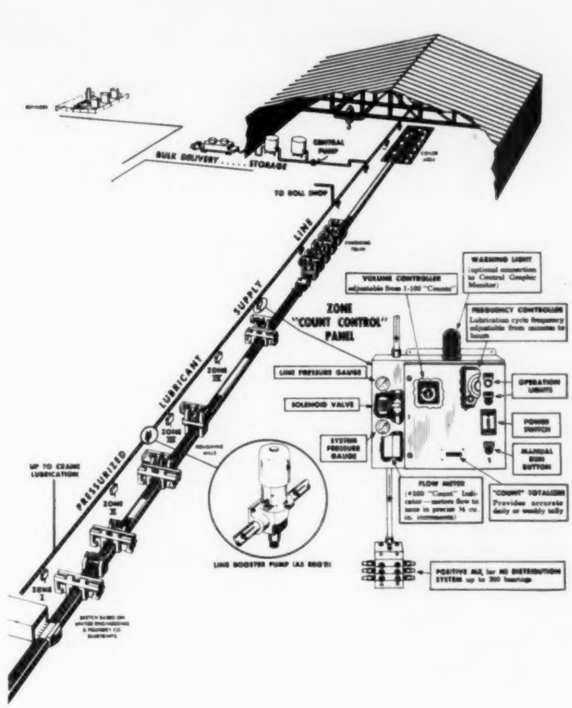

FIGURE 6.

We have reviewed some of the historical background of these systems and find that actually the first systems using metering feeder valves were installed only 25 years ago. Since that time there have been many refinements of these systems and these refinements and improvements are continuing to develop at a rapid pace. One of the latest concepts involves bulk handling of lubricants and this method, which is truly centralized lubrication, will continue to become more popular, especially in the larger plants. This method involves bulk storage of lubricant and piping it through the plant under pressure. This means treating lubricant the same as any other utility, such as steam, water, electricity, etc. This system is shown schematically in Figure 6. You will note that there are taps off the main header line. These taps lead into valves which, when opened, allow a flow of lubricant into the system. The only pumps involved are the main pumps which pump the lubricant through the header line and also the booster pumps which are installed in this line. By using these booster pumps, these lines can be run for several hundred feet. These systems can be set up to meter lubricant into the system by a time control or count control. They will signal any failure to deliver lubricant to any bearing for any of the following reasons:

- Pump failure.
- Timer failure.
- Running out of lubricant.
- Blockage anywhere in the system.
- Broken feeder line anywhere in the system.

This indication of a broken line from one central warning station, rather than installing thermo-couples at each bearing is a recent development and points up the results of the intensive work being done in this field today, to make these devices more effective in the continuing war on wear and high maintenance and repair costs. ■

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R. B. YAHN, *president of Yahn Engineering & Sales Co., Inc., Palmer, Mass., graduated from Yale university with a BS degree in chemistry in* 1943. *He was employed by the United States Rubber Co. at its Chicopee Falls, Mass., tire plant as a chemist in the product development group. He has also been employed by the Inland Manufacturing Div., General Motors Corp. as a development engineer, the Flint-Kote Products Co. in product engineering and the C. F. Church Div., American Standard as technical director. In* 1952 *he was with Ralph Symons Associates, Tiverton, R. I., specializing in hydraulic applications in the rubber and plastics molding field. In* 1954 *he formed his own company, which specializes in lubrication and hydraulic systems. He belongs to ASLE, ACS, the Society of Plastic Engineers, the Boston Rubber Group.*

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L. W. Okon	McCollister Grease & Oil Corp.

SUBCOMMITTEE ON MANUAL OF TEST METHODS & DEFINITIONS OF TERMS PECULIAR TO THE LUBRICATING GREASE INDUSTRY

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Literature and Patent Abstracts

Composition

Silica-Thickened Lubricating Grease

In British Patent 846,647, Godfrey L. Cabot Inc. describes additives and procedure which will increase the water resistance of silica-thickened lubricating greases. First, 15 to 30 per cent, based on the weight of silica, of a water-insoluble polyalkylene glycol is included and next the mixture of the ingredients is heated to 250 to 400°F for five to fifteen minutes before the mass is milled. The particular silica suggested is pyrogenic silica and the preferred additive has a viscosity at 100°F of 10 to 400 cs.

To demonstrate the effect of the proper concentration of the polyalkylene glycol, four lubricating greases were prepared by premixing for 10 minutes at 300°F. The composition and tests on the lots are shown in Table 1.

Table 1

Lot No.	1	2	3	4
Lubricating oil, parts by weight	100	100	100	100
Fine silica, parts by weight	8	8	8	8
Per cent Ucon LB-1145, based on wt. of SiO_2	5	10	15	20
Per cent water absorbed before disintegration	30	45	80	80
Per cent increase in penetration after 10,000 strokes with 10% water added	28	28	14	9

High Temperature Thread Lubricant

Gulyayev and Mironov, in *Energetik*, 1960, No. 8, pp 21-22, suggest the use of a graphite-copper powder lubricant for preventing galling or burning together of threaded connections. The composition is particularly valuable for use in connection with gas turbines. However, to be most effective the threaded surfaces should have sufficient tolerance so that initially a nut can be easily screwed onto a stud.

The lubricant consists of the following proportions by weight: 25 of powdered copper, 15 of flake graphite and 60 of glycerin.

Lubricant Thickeners Consisting of Water-Insoluble Salts of Polyvalent Metals

Hustinx in British Patent 844,683 describes the production of water-insoluble salts of polyvalent metals which are said to be suitable as thickeners for lubricants. Such products are formed by coprecipitating an alkali metal silicate and an alkali soap of a fatty acid containing at least six carbon atoms. The preferred method of preparation of the salts is to spray an aqueous solution of the mixed soap and silicate into an aqueous solution of the metal salt. Then the thickener is recovered by filtration or centrifuging and drying. Hydrophobic substances, such as mineral oil, may be present during the precipitation.

For example, a 5 per cent water solution of two mols of sodium soap of peanut oil fatty acids was mixed with a 5 per cent solution of one mol of sodium silicate. Next, the mixture was emulsified with 12 mols of lubricating oil after which

it was sprayed into a 20 per cent solution of two mols of magnesium sulfate while stirring vigorously. After the reaction was complete, the mixture was centrifuged and 0.1 mol of potassium silicate was added before the mass was dried by evaporation. The product was said to be a lubricating grease having exceptional properties, but no characteristics were given.

Sodium Silicate as a Saponifying Agent in Grease Manufacture

In Japanese Patent 2684, issued March 24, 1960, R. Suzuki describes the manufacture of a sodium base lubricating grease in which the saponifying agent consists of sodium metasilicate. Thus, 9 parts of fat were reacted with 4.1 parts of sodium silicate in the presence of about 12 parts of oil and water. The mass was then dehydrated at 150 to 160°C, further oil was added and then 0.8 parts of sorbitan monooleate. This was followed by cooling to 65 to 75°C, homogenizing and reheating to 210-215°C. The mass was then cooled to 150°C where 0.1 parts of lead stearate and 0.4 parts of phenyl alpha naphthylamine were added before addition of further oil and rapid cooling to give a product with about 9 per cent soap.

Calcium Base Lubricating Grease From Oxidized Paraffin Wax

Feng-Len Hung in *Shih Yu Lien Chih* No. 12, pp 31-32 (1958) describes the production of a calcium base lubricating grease in which the thickener is obtained by saponifying oxidized paraffin wax. The maximum temperature used in the soap formation is 106°C. After the soap-oil mass has been cooled to 100°C, water equivalent to about 3.6 per cent of the oxidized wax is added to obtain the grease structure.

Silica Thickeners in Lubricating Greases

While fine silicas are regularly used as thickeners in lubricating greases, certain statements relative to one such product are of interest. In the August, 1960 issue of *Silicate*

P's & Q's, mention is made of the fact that lubricating greases containing fine silicas as thickeners show little viscosity change between wide temperature extremes. The ultimate particles of this particular type of silica are said to have a diameter of about twelve thousandths of a micron. The micron in turn is one-thousandth of a millimeter. "For comparison, the average particle of tobacco smoke, which we normally think of as being gaseous, is at least a hundred times larger than that of our new micro fine product," that is the fine silica.

Still another type of colloidal silica, having particle sizes of 0.01 to 0.02 microns, is reported by Barnett and Cye in a paper delivered before the ACS National Meeting. In this case the silica is obtained by burning silicon sulfide vapor at high temperature. While the resulting silica is said to be useful as a thickener for lubricating greases, the particles contain up to 3 per cent of sulfur, mostly as SO_2, adsorbed on the surface which gives the silica a pH of 1.5 to 2.0. Much of this SO_2 can be removed by calcining in air at 600°C.

Manufacture of Lithium-Calcium Soap Thickened Lubricating Greases

A process for the manufacture of lithium-calcium base lubricating greases, where the molar ratio of the lithium soap to the calcium soap falls within 2:1 to 8:1, is described in U. S. Patent 2,959,548 by O'Halloran, Vesterdal and Beerbower and assigned to Esso Research and Engineering Co. Production of the suggested product is carried out in a steam heated vessel so that the soap thickeners are never melted. The preferred soap base consists of animal fatty acids having an iodine number of 40 to 60.

A typical lubricant was made from: 12.60 per cent of tallow fatty acids having an iodine number of 40 and a saponification of 200; 1.52 per cent of lithium hydroxide monohydrate; 0.71 per cent of hydrated lime; and 85.17 per cent of a lubricating oil having a viscosity of 70 SUS at 210°F. The fatty acids and about one-half of the oil were added to a steam-jacketed kettle and the lime added when the temperature reached 166°F. Heating and stirring were continued and the lithium hydroxide was added as a ten per cent water solution when the temperature reached 210°F. The mass was finally heated to 289°F to dehydrate it while additional small amounts of oil were added as the mass thickened. The total time in which the heat of the mixture exceeded 250°F was 55 minutes after which the heat was shut off and the remainder of the oil was added while stirring, over a period of one to two hours. Finally, the mass was passed through a Morehouse mill at a stone clearance of about 0.001 inch. The inlet temperature to the mill was 96°F and the outlet temperature 130°F.

The finished lubricating grease was a smooth product having a worked penetration of 280 which changed to 324 after 60,000 strokes. The dropping point was 367 and oil separation 3.5 per cent in 50 hours at 210°F. In a regular wheel bearing test, there was no leakage and the field performance of the lubricant was excellent.

Additive

Extreme Pressure Additive for Lubricating Greases

According to FitzGerald et al. (U. S. Patent 2,956,952, assigned to Esso Research and Engineering Co.), the addition of certain polymers confers EP qualities on lubricating greases. The polymers in question are those obtained either

by polymerizing bis-(beta chloroethyl) vinyl phosphonate or copolymerizing this compound with ethylene. The suggested amounts of the polymers are 0.1 to 5 per cent. As an example, a copolymer was formed containing 5.58 per cent chlorine and 2.75 per cent phosphorus. This was a grease-like material, two per cent of which raised the Almen Test Load of a base oil from 3 weights to 15 weights.

Characteristics

The Effect of Humidity on the Consistency of Greases

Max T. Fischer, Rock Island Arsenal Lab. April 27, 1960. 14 p. Report no. 60-1309, PB 161,861 from OTS, price $0.50.

When certain non-soap thickened-mineral oil greases exhibited shear breakdown after storage at low humidity, greases of other types were stored at several humidities to determine the effect on storage and shear stability. Worked and unworked quarter scale penetrations in a miniature grease worker cup were obtained on surface and subsurface grease samples stored in four-ounce ointment cans at 0, 50 and 100 per cent relative humidities maintained in desiccators for as long as seven months.

In case storage or use of lubricating greases in high or low humidity environments is anticipated, the stability of individual products should be ascertained since moisture stable and unstable greases of some soap and non-soap thickened types are available. The soap thickened-mineral oil products are more likely to be stable to the effects of moisture than are the soap thickened synthetic fluid or non-soap thickened lubricating greases.

Tests

An Accelerated Wheel Bearing Test

An accelerated wheel bearing test is suggested by O'Halloran, Vesterdal and Beerbower, in U. S. Patent 2,959,548, which is said to distinguish between an acceptable grease and an outstanding wheel bearing lubricant.

In this accelerated test, the wheel bearing assembly (see ASTM Method D 1263-53T) is tilted 15 degrees toward the shield. With a regular charge of 90 grams of the lubricating grease in the bearings and hub, the motor is started and both heaters are left on until the spindle temperature has been raised to about 200°F (about 20 minutes) and the oven temperature to about 235°F. An electric vibrator attached to the back of the oven next to the spindle support bolts is then started and left on for one hour. The spindle temperature is then about 215 to 220°F. The amount of grease slumped into the shield is weighed to determine whether the lubricant passed or failed the test.

Three lithium-calcium base products which all passed the regular wheel bearing test, gave respectively 0.5, 8.5 and 19.5 grams leakage on the accelerated test, thus indicating a pass, a borderline and a failure, which ratings were confirmed by field performance.

Tests with a Modified Kugel-Fischer Grease-Tester

Wear v. 3 (1960) p. 80 in reporting on a Seminar on Friction, Lubrication and Wear, held at Burgenstock, Switzerland, Sept. 17-19, 1959, mentions that G. Spengler showed a high speed film of the behavior of lubricating greases in the ball bearings of the above tester.

Standard bearings with specially treated surfaces have to be obtained for use with this apparatus. Further, consistent results can only be obtained with lubricating greases containing no additives, since additives will change the bearing surfaces permanently and lead to errors in subsequent tests. Therefore, it is the practice to test unknown products on a four-ball tester before using the Kugel-Fischer tester.

Spengler was concerned with measuring friction, adhesion and flow of the lubricating greases and not wear. The machine is used by manufacturers of lubricating greases to control production because results can be obtained in a very short time. Further, the test has been made obligatory by the purchasing department of the German Postal Administration.

Structure Modifiers

Gelation of Soap in Hydrocarbons

O. Henning, *Kolloid-Z.* 169, 76-85 (1960), describes experiments to determine the gelation of pure sodium stearate in various solvents and concentrations. Additives, serving as structure modifiers, were included in most mixtures. The standard mixture consisted of 70 mg. of the soap, 30 mg. of the additive and 25 cc of the solvent.

Among the additives investigated, stearic acid, oleic acid and stearamide were the most effective promoters of gelation. The solvents used were, in addition to hydrocarbons and their halogen derivatives, alcohols, esters and ethers.

To determine the strength of the gels, a torsion effect was measured with an apparatus having concentric cylinders, one of which rotated.

Illustrated Bulletin

An illustrated bulletin describing automatic cartridge and tube fillers for oil, grease, caulking, ink and other viscous products, is available from the Filler Machine company, 10 Penn Ave., Philadelphia 11, Pa., and shows the applications and advantages of these high production fillers which feature automatic feed of cartridges and rigid tubes to save hand labor, no container—no fill protection that eliminates waste and mess, piston-filling for exact measure of set amount, bottom-up fill that prevents air pockets, and automatic plug pressing for uniform, correct closure.

For a copy of this interesting bulletin on Geyer Automatic Piston Fillers for Cartridges and Rigid Tubes, write to the Filler Machine company, at the above address.

Industry News

Werner G. Smith Names Sales Representative

The Brefflich Co., 501 North Jefferson Davis Pkwy., New Orleans 25, La., has been appointed sales representative for Werner G. Smith, Inc. The Brefflich Co. is headed by Mr. Louis Brefflich who has been associated with the chemical industry in New Orleans, La., and surrounding territory for over fifteen years.

The Brefflich Co. is well equipped to serve industries, both technically, and backed by long experience in the diversified chemical, paper, paint, petroleum, plastic and allied industries.

New Humble Bulk Grease Truck Now in Use

Tests of Humble Oil & Refining company's new bulk grease truck have been completed and the first delivery has been made to the Midland works of Crucible Steel.

Crucible's new bulk grease handling system at its Midland (Pa.) plant is the first in this area. But research has been under way for several years to devise new and more efficient methods of handling lubricants in the steel and other heavy industries.

Crucible's system – designed by G. C. Almasi, the firm's lubrication engineer–is expected to save at least 40 per cent compared to conventional lubricant handling methods. Economies result from simplified handling of lubricants in a bulk system, reduction of waste and lower prices because container costs are eliminated.

Humble's specially-designed $50,000 truck has a semi-trailer body with three canister compartments, each with a capacity of 10,500 pounds. Most deliveries will be made from the company's Pittsburgh plant, largest grease manufacturing plant in the free world.

Crucible's bulk handling set-up was designed for its new 54-inch hot strip mill. Twenty thousand pounds of grease–the first delivery by the Humble carrier–were required to fill the system. The grease is piped direct from Crucible's two receiving tanks to the centralized lubrication network.

Other anticipated advantages, besides lower handling costs, are cleaner and safer working conditions, reduced contamination of lubricants and savings in floor space.

At the Humble grease plant, the grease was loaded in the insulated truck at a temperature of about 130 degrees. It is estimated there is a heat loss of only one degree an hour after loading. A gasoline engine at the front of the trailer powers a hydraulic pump and this pump provides the power for the individual motors and pumps for each canister. A full canister can be unloaded in 26 minutes.

According to Humble, it will make bulk deliveries as far west as Chicago and east to the Atlantic Seaboard. Some may be made from the grease plant at the company's Baltimore refinery.

One, two or three types of grease can be shipped at a time without intermixing, because of the separate canister compartments. The bottom outlet of each canister is connected to the suction side of its individual pump when unloading starts.

The grease plant uses its own pumps for loading. Those on the truck were not designed to be reversed to handle loading as well as unloading. Separate pumps for each canister eliminate manifolding, another stage where contamination might occur. The canisters are loaded, as well as unloaded, through the bottom outlet.

The new grease carrier was built for Humble by the Columbian Steel Tank company of Kansas City, Mo.

New GSA Bids On Graphite

The General Services Administration has announced that no acceptable bids were received for the purchase of surplus graphite recently advertised by GSA. The General Services Administration will now consider offers on a negotiated basis for all or portions of the 740 short tons of graphite. Twenty-eight short tons of the graphite are Ceylon amorphous lump; the balance is crystalline flake. Amorphous lump is used in carbon brushes, brake linings, paints and other commercial products. Flake graphite, of the quality being offered by GSA, is suitable for use in lubricants and packings.

Offers to purchase and requests for information should be made to the Director, Project Administration Division, Defense Materials Service, General Services Administration, 18th and F Streets, N. W., Washington 25, D. C.

Fight Plant Blaze At Southwest

What might have been a disastrous fire was quickly brought under control and production continues at Southwest Grease & Oil company of Wichita, Kansas, while plans are already under way for replacement facilities. This industry hazard was met and contained, thanks to quick action by trained employees, regular safety practices, and excellent fire fighting.

Monday, February 27, 1961, was a fateful day in the 28-year history of Southwest. At 10:50 a.m., fire broke out in and around the grease kettles located on the second floor of Plant I. The fire quickly spread throughout the entire floor, momentarily trapping seven employees working in the grease manufacturing area. These seven men escaped after first turning in the fire alarm and then fighting the blaze until it was far beyond their control. One hundred forty regular, reserve and volunteer firemen arrived to battle the blaze. It required a good two hours, plus all the skill and teamwork the firemen could master to bring it under control. They were successful in confining the fire to the one two-story building, its place of origin.

H. A. Mayor, Jr., executive vice-president, was quick to give credit to the heroic efforts of the seven employees for their quick thinking in getting the alarm turned in without delay and especially to one employee, Milton Molz, a greasemaker, for remaining behind after all had escaped, to make one last effort to extinguish the fire. Four of the seven were burned in the fire—receiving first, second, and third degree burns—mostly to their faces, hands and arms. All are now making rapid and complete recovery. Mr. Mayor also praised the Wichita Fire Department for their performance.

Another factor which undoubtedly saved the remainder of the plant from sure damage was the perfect functioning of the five fire doors leading from the area where the fire originated. Several years ago, Sowesco initiated a daily inspection of these doors to be sure of their workability in case of emergency. It paid off in big dividends.

That afternoon, following the fire, production was resumed in undamaged areas. Several truck loads of grease and oil were shipped the very afternoon of the fire and Tuesday morning found all Southwest employees, except those injured, back on the job.

Harold Mayor, Sr., president, returned home from Sidney, Australia on Wednesday, following the fire. Mr. Mayor examined first hand the damage to the one time livery stable which he converted into a world-wide grease and oil business. He stated that the old building had had a lot of grease and oil pass through it during the past 28 years. Even though he was disap-

Authors

Are you engaged in research, the description of which might make an interesting technical article for the NLGI SPOKESMAN? *Has your firm completed a marketing program on grease that sparked sales? Your Institute's journal is always on the lookout for feature material on lubricating greases and fluid gear lubricants, and you are invited to submit a paper to a world-wide audience.*

There are no restrictions as to length or content, and any number of illustrations are allowed. (When technical data is quoted, tables, charts or graphs should be given, to insure accuracy and quality, as required by the editorial review committees.) Material should be sent to the Editor, NLGI SPOKESMAN, 4638 *J. C. Nichols Parkway, Kansas City* 12, *Missouri.*

pointed to see "the old homestead" go in this manner, he immediately began planning the new building which is being erected in its place. He stated the new structure will again be a two-story building, but will be of an all steel and cement construction in order to make it fireproof. He mentioned that all the buildings the company had constructed, versus the buildings they had acquired, were of this same fireproof construction. Several new kettles and tanks will be added to the new building thereby increasing production efficiency.

H. A. Mayor, Jr. summed up the ordeal by optimistically looking toward future months and years. He said the fire, of course, was regrettable. "We are also thankful the fire was no worse than it was and that we can now enthusiastically plan towards the day this spring when the first pound of grease will be processed through our new building."

People in the Industry

ADM Names Thompson Director of Research

Appointment of Dr. William E. Thompson, San Antonio, Tex., as director of research for Archer-Daniels-Midland company was announced by Dr. James C. Konen, vice-president in charge of research and development for ADM.

Dr. Thompson formerly was director of the department of chemistry and chemical engineering at Southwest Research Institute. He will assume his new position at ADM's central research laboratory in Minneapolis.

Dr. Konen has been director of research in addition to his responsibilities for over-all direction and administration of ADM's research, development, engineering and quality control programs. Appointment of a separate research director reflects the increasing scope of the company's research activities which are highlighted by plans to begin construction of a new central research laboratory building in Bloomington, Minn., this spring.

Before his association with Southwest Research Institute in 1957, Dr. Thompson was a section chief in the basic research section of Sun Oil company, which he joined in 1951. He directed research and development of new products, including polyolefins, drilling fluids, oxidized waxes and petroleum sulfonate derivatives and the oxidation of aromatics which led to some of his numerous patents.

Dr. Thompson holds a doctor's degree in physical chemistry from Johns Hopkins university. He also taught at Johns Hopkins and Southwestern college at Memphis, Tenn. He is a member of the American Chemical Society and the American Oil Chemists Society.

Appointed Manager, New Product Development

The appointment of John R. Jones as manager, new product development has been announced by Alfred Sonntag, president, the Alpha-Molykote corporation, Stamford, Conn. In this position, Mr. Jones will be responsible for the development of new lubricants to meet increasingly demanding requirements of modern technology for more effective boundary lubrication.

Mr. Jones joins Alpha-Molykote from the Boeing Airplane company where he has been materials engineer in charge of fuels, lubricants and hydraulic fluids in the transport division. Recently, for Boeing, he has been coordinating the study of friction in a vacuum being conducted by the Franklin Institute. Mr. Jones' 13 years experience in the lubrication field also includes employment with Douglas Aircraft Co. and the Esso Standard Oil Co. He holds many patents in the lubricant and lube oil additive fields.

Active in technical society affairs, Mr. Jones is a member of the Coordinating Research Council, and has served on various committees of the ASTM and ARTC. He was leader of the C.R.C. panel on service evaluation of ball and roller bearings, and is now a member of the C.R.C. panel on bonded solid film lubricants.

Mr. Jones holds a B. S. in chemistry from Trinity college, Hartford, Conn., and served in the Infantry and Chemical Warfare service during World War II.

California Research Promotes J. L. Dreher

J. L. Dreher has been promoted from group supervisor to supervising research chemist, greases and industrial lubricants section, Richmond laboratory, California Research Corp.

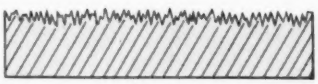
Dreher has long been active in NLGI affairs, is currently vice-chairman of the subcommittee on the procurement of technical papers for the NLGI SPOKESMAN and is a member of the fundamental research subcommittee.

CLIMAX MOLYBDENUM

Molysulfide® News Digest

CLIMAX MOLYBDENUM COMPANY, a division of American Metal Climax, Inc., 1270 Avenue of the Americas, New York 20, N.Y.

MOLYSULFIDE INCREASES TOOL LIFE AS MUCH AS 300 PER CENT



When magnified, a piece of highly polished metal is actually smooth to touch, yet presents a cross-section of saw-tooth irregularity. Molysulfide fills in the valleys, prevents the peaks from tearing, permits plastic deformation of the metal to make a smoother surface.

COMPOUND CONTAINING MOLYSULFIDE REDUCES MACHINERY WEAR-IN TIME

During the wear-in period of machinery, permanent surface damage . . . variously described as *galling, scuffing, scoring, tearing, scratching, excessive abrasion* and *seizing* . . . is an inherent hazard.

After years of experience, leading equipment builders agree that an MoS_2 compound is the best guarantee against wear-in damage. Here are five ways such a compound, applied to moving parts prior to operation, can save you wear-in time, money and possible grief:

1. Shortens wear-in period without use of abrasives.
2. Eliminates stick-slip behavior and resists galling and seizing at bearing pressures far beyond the yield point of any metals.
3. MoS_2 particles have a tenacious adherence to bearing surfaces. Will not scrape off.
4. Need not be burnished into surface. Brush or wipe on a thin coating.
5. Inexpensive in the long run. A little goes a long way.

When writing, refer to CL-103

MoS_2 Provides Greater Resistance to Wear at High Temperatures

The Alpha-Molykote Corporation in Stamford, Conn., is now marketing a new Molysulfide bonded lubricant for ferrous surfaces.

Applied with a conventional paint spray gun, this compound fills the microscopic valleys of the surfaces of tool steel and gives on-the-spot lubrication that allows the chips to glide. Once sprayed, it dries at room temperature to a tough film that has a thickness of 0.0001—0.0008 in. and a coefficient of friction of 0.03 at 100,000 psi.

Extremely resistant to wear at high pressures and temperatures (operating temperature range -300 to 600 F) this new compound requires neither chemical nor mechanical surface pretreatment and, because of its high adherence and low friction coefficient, it increases cutting tool life as much as 300%.

Effectiveness of this lubricant comes mainly from the weak layer-to-layer bonds which allow easy sliding and, within individual layers, from the cohesive forces between Mo and S atoms that are quite strong and prevent penetration by surface asperities.

Minimum coverage coating is 285 sq. ft./lb., and consumption is about 1% of tool weight. Normal lubricating oils, cutting fluids or solvents have no effect on these coatings.

When writing, refer to CL-101

Punch Life Increased from 2,000 to 25,000 Holes in Steel Plate

These punches (11/16") were used to punch 25,000 holes in ½"—1020 cold rolled steel plate. Without a lubricant containing MoS_2, a maximum life of only 2,000 holes could be obtained.

A West Coast manufacturer was experiencing low punch life with the best available lubricants. His multiple punching operation consisted of cold shearing 50 holes simultaneously in a single steel plate. A maximum life of 2,000 holes per punch was obtained with ordinary lubricants.

Then, a compound containing Molysulfide was applied to the punch. The result: punch life was increased from 2,000 to 25,000 holes and, as can well be imagined, considerable savings were effected.

When writing, refer to CL-102

National Lubricating Grease Institute
4638 J. C. Nichols Parkway, Kansas City 12, Missouri

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